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The Patent Office

Cardiff Road  
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1. Your reference

P.77018 GCW.CMK

2. Patent application number

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18 AUG 1999

9919573.7

3. Full name, address and postcode of the or of each applicant (underline all surnames)

OXFORD NATURAL PRODUCTS PLC.

No.1 St Giles,  
Oxford OX1 3JS

Patents ADP number (if you know it)

If the applicant is a corporate body, give the country/state of its incorporation

United Kingdom

760043000/✓

4. Title of the invention

PROCESS FOR QUALITY CONTROL OF MEDICINAL  
PLANT PRODUCTS.

5. Name of your agent (if you have one)

J A KEMP & CO

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

14 SOUTH SQUARE  
GRAY'S INN  
LONDON WC1R 5LX

Patents ADP number (if you know it)

2000/✓

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application number  
(if you know it)

Date of filing  
(day / month / year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing  
(day / month / year)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer "Yes" if:

Yes

- a) any applicant named in part 3 is not an inventor, or
  - b) there is an inventor who is not named as an applicant, or
  - c) any named applicant is a corporate body:
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# Patents Form 1/77

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Continuation sheets of this form

Description 4

Claim(s) 3

Abstract 1

Drawing(s)

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for preliminary examination and search (Patents Form 9/77)

Request for substantive examination (Patents Form 10/77)

Any other documents (please specify)

11. I/We request the grant of a patent on the basis of this application

Signature

J A Kemp & Co

Date 18 August 1999

12. Name and daytime telephone number of person to contact in the United Kingdom Mrs C M Keen  
0171 405 3292

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PROCESS FOR QUALITY CONTROL OF MEDICINAL PLANT  
PRODUCTS

5 The present invention relates to the quality control of medicinal and  
nutritional substances derived from plants. In particular the invention relates to a  
process for producing a plant based medicinal or nutritional substance which satisfies  
a pre-defined pharmaceutical grade standard and which can therefore be licensed by  
drug regulatory authorities as a pharmaceutical product. The invention also allows  
the origin or quality of a plant based material to be determined by comparison with a  
10 standard, thereby providing a means for the standardisation, quality control, tracking  
and audit of such materials.

Many societies around the world have developed, through the centuries, a  
system of traditional medicine relying largely on the use of plants and herbs as  
therapeutic substances. Studies into the structures of the isolated active ingredients  
15 of these substances led to the chemical phase of drug discovery in the early and  
middle twentieth century. As a result some important drugs were developed which  
owe their origin to the empirical use of plants in traditional medicine.

In recent years there has been a significant growth of interest amongst the  
general public in the direct use of plants and plant extracts as health modifying  
20 agents, for instance ginseng, garlic, *Ginkgo biloba*, *Hypericum* (St John's wort),  
*Echinacea* and *Aloe Vera*. These are currently available on the market as herbal  
products and dietary supplements and annual sales of these products worldwide are  
currently in excess of £10 billion. In spite of this marketing potential the  
mainstream pharmaceutical industry has not so far directed its attention to the  
25 development of medicinal products derived from plants. This is due in part to  
problems associated with the complex nature and inherent non-uniformity of plant  
materials, including the lack of an established system by which drug regulatory  
approval for such products can be secured.

The materials used in herbal and plant based medicine are usually whole  
30 plants, parts of plants or plant extracts. Since plant materials contain many different  
chemical components the materials are, by definition, complex mixtures. This makes  
it very difficult to standardize and control the quality of the materials. Furthermore,

plants used in the practice of herbal medicine are frequently unavailable locally and therefore need to be obtained from sources which are remote from the end user.

However, the supply of such plants from remote locations can be erratic and inaccurate, particularly because no detailed monographs (identity and quality standards) exist for the plants. The complex mixture of ingredients found in medicinal plants will in any event vary widely in type and concentration depending on many factors including the botanical origin, the location where the plant is grown, the time or year when the plant is harvested and the extraction procedure used.

As a consequence it is virtually impossible to provide any assurance that samples of a given plant material obtained from disparate sources will possess a uniform identity and biological activity. This inherent variability of plant materials presents a problem to the drug regulatory authorities who need to be convinced that a candidate product for pharmaceutical licencing is of a consistent and verifiable quality. This is so that, for instance, the effectiveness of dosage levels and treatment protocols can be guaranteed. However, there is no reliable system available at present which both allows the identity and activity of a plant based product to be measured against an accepted standard and is universally applicable to all kinds of plant material.

The present invention addresses this problem and, in one aspect, provides a process for producing a pharmaceutical grade therapeutic substance which is derived from, or consists of, a plant material, the process comprising:

- (i) providing a test sample of the therapeutic substance in the form of a solution or extract;
- (ii) submitting the test sample to high resolution NMR to generate an NMR fingerprint;
- (iii) determining whether the NMR fingerprint generated in step (ii) matches that of a pre-determined pharmaceutical quality standard sample; and
- (iv) selecting the therapeutic substance as being of pharmaceutical grade only if the NMR fingerprint matches that of the said standard sample.

The invention thus resides in the application of high resolution NMR techniques to the characterisation and/or standardisation of a plant-derived substance. The substance can be accepted or rejected depending on whether its NMR fingerprint matches that of a pre-determined pharmaceutical grade standard.

5           The high resolution NMR fingerprinting technique typically comprises:

- (i)     submitting the test sample to high field proton NMR and recording one or more NMR spectra;
- (ii)    evaluating the data obtained from the or each NMR spectrum by one or more computer-based pattern recognition procedures to obtain an  
10       NMR fingerprint of the sample; and
- (iii)   determining the presence or absence of marker features in the fingerprint which have been previously identified in the NMR fingerprint of a pharmaceutical quality standard sample.

          The high resolution NMR fingerprinting technique thus involves a  
15       combination of  $^1\text{H}$  NMR at high fields and computer based pattern recognition procedures. The NMR spectra are typically measured at 400 to 700 MHz, and the data derived from them are analysed by computer programs using techniques such as non-linear mapping and principal component analysis. Examples of the high resolution NMR fingerprinting technique are discussed by M. L. Anthony *et al* in  
20       Biomarkers 1996, 1, 35- 43 and Molecular Pharmacology 46, 199- 211, 1994, and by J.O.T. Gibb *et al* in Comp. Biochem. Physiol. vol. 118B No. 3, pp 587- 598, 1997.

          An important advantage of this NMR technique is that it is not limited by a selective delivery or detection system. Spectra are recorded without prior  
25       purification of the test sample, thus allowing all components of the sample to contribute to the overall NMR "fingerprint". Analysis by the pattern recognition procedures as discussed above reveals potential valuable marker features of the spectra which can be used with a high degree of precision in the characterisation of the complex mixtures of components contained in plant materials.

          In the process of the invention the therapeutic substance typically consists of,  
30       or is derived from, a whole plant, a part of a plant, a plant extract or a plant fraction. Preferably the substance consists of, or is derived from, one or more of the roots, leaves, buds, flowers, fruit, juice and seeds of a plant.

The process of the invention as described above relies upon the prior establishment of a pharmaceutical grade quality standard for the therapeutic substance in question, which is submitted to high resolution NMR to yield a characteristic NMR fingerprint. The pharmaceutical grade quality standard for a therapeutic substance which is derived from, or consists of, a plant material may therefore be provided by a process comprising:

- (i) providing a test sample of the therapeutic substance, of the quality desired for the standard, in the form of a solution or extract;
- (ii) submitting the test sample to high resolution NMR to generate an NMR fingerprint; and
- (iii) defining the NMR fingerprint obtained in step (ii) as the standard to be met by any sample of the substance which is to be recognised as being of the desired pharmaceutical grade quality.

In another aspect the present invention further provides a process for determining whether a nutritional or therapeutic substance which derives from, or consists of, a plant material, has a specified origin or a desired quality, the process comprising:

- (i) providing a test sample of the substance in the form of a solution or extract;
- (ii) submitting the test sample to high resolution NMR to generate an NMR fingerprint;
- (iii) determining whether the NMR fingerprint matches that of a previously tested standard sample having the specified origin or desired quality in question; and
- (iv) selecting the substance as being of the specified origin or desired quality only if the NMR fingerprint matches that of the said standard sample.



CLAIMS

1. A process for producing a pharmaceutical grade therapeutic substance which is derived from, or consists of, a plant material, the process comprising:
  - 5 (i) providing a test sample of the therapeutic substance in the form of a solution or extract;
  - (ii) submitting the test sample to high resolution NMR to generate an NMR fingerprint;
  - 10 (iii) determining whether the NMR fingerprint generated in step (ii) matches that of a pre-determined pharmaceutical quality standard sample; and
  - (iv) selecting the therapeutic substance as being of pharmaceutical grade only if the NMR fingerprint matches that of the said standard sample.
- 15 2. A process according to claim 1 wherein the high resolution NMR technique comprises:
  - (i) submitting the test sample to high field proton NMR and recording one or more NMR spectra;
  - 20 (ii) evaluating the data obtained from the or each NMR spectrum by one or more computer-based pattern recognition procedures to obtain an NMR fingerprint of the sample; and
  - (iii) determining the presence or absence of marker features in the fingerprint which have been previously identified in the NMR fingerprint of a pharmaceutical quality standard sample.
- 25 3. A process according to claim 2 wherein the computer-based pattern recognition procedures include non-linear mapping, principal component analysis and cluster analysis.
- 30 4. A process according to any one of the preceding claims wherein the therapeutic substance consists of, or is derived from, a whole plant, a part of a plant, a plant extract or a plant fraction.

5. A process according to any one of the preceding claims wherein the therapeutic substance consists of, or is derived from, one or more of the roots, leaves, buds, flowers, fruit, juice and seeds of a plant.  
5
6. A pharmaceutical grade therapeutic substance produced by a process as claimed in any one of claims 1 to 5.
7. A process for determining whether a nutritional or therapeutic substance  
10 which derives from, or consists of, a plant material, has a specified origin or a desired quality, the process comprising:
  - (i) providing a test sample of the substance in the form of a solution or extract;
  - (ii) submitting the test sample to high resolution NMR to generate an  
15 NMR fingerprint;
  - (iii) determining whether the NMR fingerprint matches that of a previously tested standard sample having the specified origin or desired quality in question; and
  - (iv) selecting the substance as being of the specified origin or desired  
20 quality only if the NMR fingerprint matches that of the said standard sample.
8. A process according to claim 7 wherein the high resolution NMR technique comprises:  
25
  - (i) submitting the test sample to high field proton NMR and recording one or more NMR spectra;
  - (ii) evaluating the data obtained from the or each NMR spectrum by one or more computer-based pattern recognition procedures to obtain an NMR fingerprint of the sample; and
  - 30 (iii) determining the presence or absence of marker features in the fingerprint which have been previously identified in the NMR fingerprint of the standard sample.

9. A process according to claim 8 wherein the computer-based pattern recognition procedures include non-linear mapping, principal component analysis and cluster analysis.
- 5 10. A process according to any one of claims 7 to 9 wherein the nutritional or therapeutic substance consists of, or is derived from, a whole plant, a part of a plant, a plant extract or a plant fraction.
- 10 11. A process according to any one of claims 7 to 10 wherein the therapeutic substance consists of, or is derived from, one or more of the roots, leaves, buds, flowers, fruit, juice and seeds of a plant.
- 15 12.. A process for providing a pharmaceutical grade quality standard for a therapeutic substance which is derived from, or consists of, a plant material, the process comprising:
- 20 (i) providing a test sample of the therapeutic substance, of the quality desired for the standard, in the form of a solution or extract;
- (ii) submitting the test sample to high resolution NMR to generate an NMR fingerprint; and
- (iii) defining the NMR fingerprint obtained in step (ii) as the standard to be met by any sample of the substance which is to be recognised as being of the desired pharmaceutical grade quality.

ABSTRACT

PROCESS FOR QUALITY CONTROL OF MEDICINAL PLANT PRODUCTS

5           A process for producing a pharmaceutical grade therapeutic substance which is derived from, or consists of, a plant material, the process comprising:

- (i)     providing a test sample of the therapeutic substance in the form of a solution or extract;
- (ii)    submitting the test sample to high resolution NMR to generate an  
10       NMR fingerprint;
- (iii)   determining whether the NMR fingerprint generated in step (ii) matches that of a pre-determined pharmaceutical quality standard sample; and
- (iv)    selecting the therapeutic substance as being of pharmaceutical grade  
15       only if the NMR fingerprint matches that of the said standard sample.

The invention thus provides a means for the quality control of medicinal plant products and thereby overcomes problems associated with the inherently complex nature and variable quality of plant materials.